Investigação

STATIC CREEP OF A RESIN COMPOSITE, A GLASS IONOMER CEMENT AND A COMPOMER.

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RESUMO

A proposição desta investigação foi estudar o creep Estático de alguns polímeros dentais usando o teste de creep descrito na especificação nº 1 para amálgamas da ADA. Os materiais foram preparados de acordo com as indicações dos fabricantes e inseridos numa matriz de aço de 4mm de diâmetro por 8mm de altura. Foram armazenados cinco espécimes cilíndricos de cada material em água destilada a 37ºC ± 1ºC durante 7 dias. Uma pressão estática de 36 MPa foi então aplicada por 4 h permitindo-se 4 h de recuperação da tensão depois de remoção da carga sempre com o conjunto, imerso em água à temperatura constante de 37ºC± 1ºC. As variações medidas após as 4 h foram registradas e o creep foi computado como segue: Creep (%) igual à alteração entre o comprimento original e o final depois do ensaio, dividido pelo comprimento original e multiplicado por 100. O comportamento do creep estático, como um fator de análise, mostrou que não existe diferença estatística significante entre o compômero e ionômero de vidro. Os valores médios encontrados nos dois produtos testados, o compômero e o cimento de ionômero de vidro, foram considerados inferiores aos da resina composta para restauração.

Palavras-chave: *creep, viscoelesticidade, resina composta, cimento de ionomero de vidro.*

ABSTRACT

The aim of the present investigation was to study the static creep of 3 selected dental polymers using the test described in the ADA Specification nº 1 for amalgams. The materials were prepared according to the manufacture's directions and placed into one steel matrix, in a cavity 4mm in diameter and 8mm height. Five cylindrical specimens of each material were preliminary stored in distilled water at 37ºC ± 1ºC for 7 days. A static stress of 36 MPa was then applied continuously on each sample 4 h. Load was removed and strain recovery was permitted for other 4 hours.

The device was always immersed in water during the experimental at 37ºC. The changes in length after 4 h readings were recorded and the Creep calculated according the above mentioned ADA specification. A one-factor analysis showed to be no statistically significant differences between the results of the compomer and the glass ionomer cement. The best results have been presented by the resin composite.

Key words: *creep, resin composite, glass ionomer, compomer*

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INTRODUCTION

Creep is a process referred to material that is subjected to continuous load pressure resulting in alteration of its length in function of the duration of the applied load. Non crystalline, viscoelastics or plastics materials, subjected to low tensions by long period of time, show a permanent deformation called "static creep", which is the percentage value between the variation in length and the original length. Static creep is time-dependent deformation produced in a solid subjected to a constant stress. Dynamic creep refers to the similar phenomenon when applied stress is fluctuating, such as that in a fatigue test[8]. This creep feature could be well represented by a generalized linear viscoelastic model [9].

The application of ultrasound to conventional glass ionomer cement imparts a command set, which improves the short-term surface mechanical properties. The hardness of surface of chemically glass ionomer cement increase magnitude when set ultrasonically whilst creep reduced to a negligible amount. Rapid setting allows for shorter chair time and an improved clinical technique, making restorations more convenient to patient and clinician[10].

In restorations under continuous stress, such as bruxism, the deformation behavior, i.e. the creep properties of various types of restorative materials, may be interesting. Viscoelastic creep value of less than 2% is acceptable for composites at the stress-levels applied. However the increase in creep response in double by compomer suggests these materials as unsuitable for stress-bearing areas[5].

The aim of the present study was to determine the creep response of a resin composite, and compare it to conventional glass ionomer cement and compomer.

MATERIALS AND METHODS

Hybrid resin composite, compomer and glass ionomer cement were selected for comparative purposes. The individual characteristics of each material are listed in Table 1.

Table 1- Characteristics of the materials

products	composition	description	manufacturer
SUPRAFILL	BISGMA; TEGMA UEDMA; BA_2; SIO_4	RESIN COMPOSITE	SSWHITE
DYRACT	SrFS; TCB; UDMA	COMPOMER	DENTSPLY
VIDRIONIO ENCAP	SIO_2-AL_2O_3-CAF_2-AL_2PO_4-NA_2F_6	GLASS IONOMER	SSWHITE

The viscoelastic parameters of polymers in compression creep have been measured. Volume deformations (%) increase as pressure and temperature increase[1].

The viscoelastic behavior of the material was studied using the creep test described in the American Dental Association, specification nº 1 for amalgams[2]. Creep measurement apparatus, was used to subject each specimen, and consisted of a lever, which pivoted at one end via a bearing pin, in a vertical pillar bolted to a steel U-section base. The specimen was located on a raised platform in axial alignment with the loading pin, so that a force could be directed to the end faces by application of loading weights to the free end of the lever. A small water bath was mounted on specimen platform. One 8mm thick inox steel matrix containing a circular orifice with 4mm diameter was placed on the bottom of a glass plate. The materials were prepared according to the manufacture's directions and placed into the cavities. The topside of the cavities was covered with a polyester strip and a glass slide. The resin was light-cured for 60 s on each end (top and bottom) of the cavities with an Optilux 401 (Kerr, USA) light-curing unit with an output of 580mW/cm2. The compomer and the glass ionomer cement were also condensed into the cavities and allowed to set for 15 min after mixing. Five cylindrical specimens of each material were stored in distilled water at 37ºC ± 1ºC for 7 days. Preparation was completed upon removal from the matrix by carefully trimming any excess flash from ends with 600 grit silicon carbide paper, thus further ensuring that the end faces were parallel and also perpendicular to the long axis.

The axial length of each specimen was measured with a micrometer (0,0001mm) and recorded as original length. Then a static stress of 36 MPa was applied continuously on the sample for 4 h samples have then been permitted a 4 h with strain recovery, after load removal always at constant temperature of 37ºC ± 3ºC and the samples immersed in water during the experiment. The changes in length after 4 h readings were recorded and the Creep were computed as follows: Creep (%) equals length change between original and four hours divided by original length multiplied by 100 (Fig. 2).

The Measured values of the degree of deformation were then analyzed by one-way ANOVA ($p<0, 05$).

RESULTS

An example of the general pattern of the creep and recovery curves is illustrated in Figure 1. The results achieved from the measurements of the creep test demonstrated to be similar for the Dyract compomer and the Vidrion cement; however, the Suprafill resin was statistically different. The smallest creep values for the Suprafill were probably due to the larger amount of organic content. The means presented in Table 2 reveal that the creep depends on the fraction of volume of inorganic fillers and on the structure of the matrix.

An instantaneous elastic response to the initial loading is followed by a time-dependent Viscoelastic deformation (creep stage) in function of the duration of the loading period. During unloading (recovery) there was an initial recovery followed by a permanent set (E) which was irreversible

DISCUSSION

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Creep is related to the density and amount of water in order to have a correct determination of the load, when established the models for the creep test. The property, for the glass ionomer cement, is considered of utmost importance for its performance when subjected to oclusal strain. The immersion in water has various effects upon the tested materials. Water may cause a swelling of the materials.

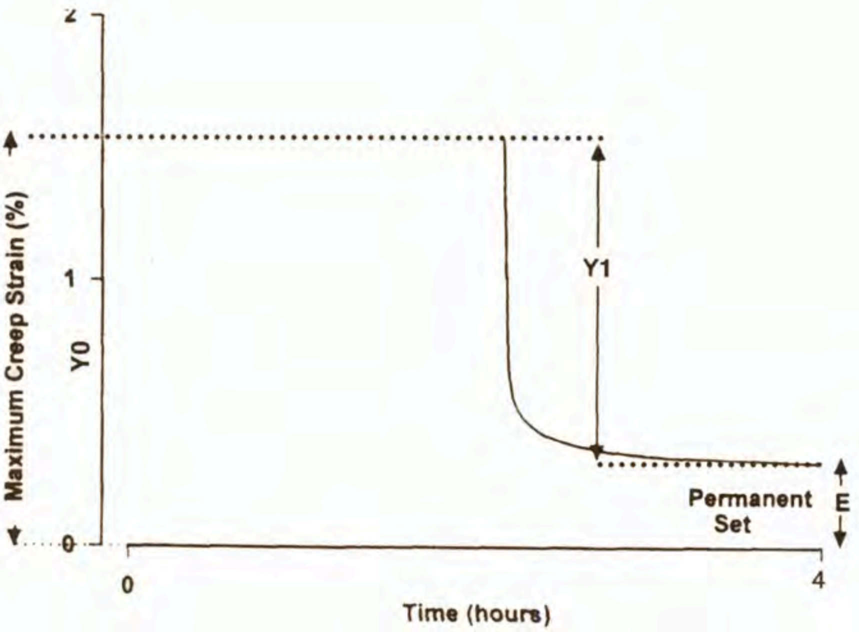

Figure 1 - Viscoelastic parameters

The original length values were measured for each specimen and permanent strain and the creep was calculated according to the specification nº 1 of ADA[2] (1977).

Products	Original Size (mm) Yo	Final Size (mm) Y1	Creep (%) (Yo – Y1)/ Yo
SUPRAFILL	7.99 (0.001)	7,86 (0.003)	1,62 A
DYRACT	7.96 (0.004)	7,76 (0.004)	2,75 B
VIDRION CAPS.	7,99 (0.005)	7,81 (0.006)	2,37 B

Table 2 - Legend: – Capital letters that precedes the medium ones (A<B) show the comparison among the different composite resins for same polymerization type. Vertical sense of arrow

The conventional glass ionomer cement, *Vidrion caps*, absorbs relatively large amounts of water, although this material does not swell much. Approximately 24 per cent of the set cement is water and, until the formation of aluminum polyacrylate chains is well advanced, water-soluble calcium polyacrylate chains can take up further water[11]. The *Dyract* has dual polymerization. The Kinetics of subsequent acid-base reaction is different from those of glass ionomer cements. A latter hardness instantly appears once exposed to moisture. With *Dyract* the acid-base reaction cannot occur instantly, as the material initially does not contain water; consequently, it exhibits a

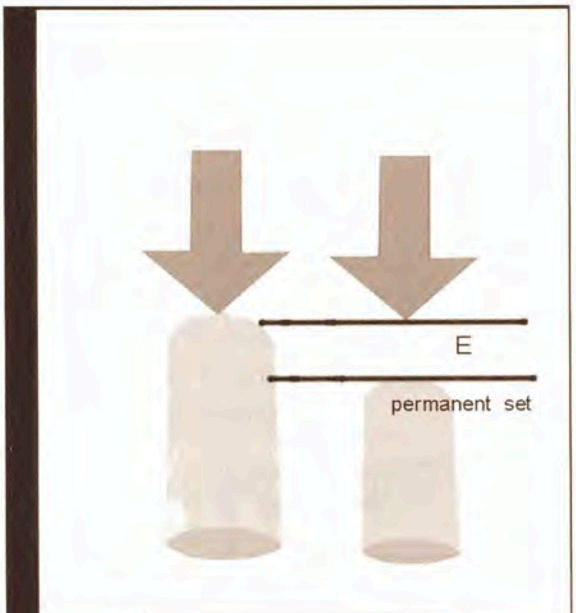

Figure 2 - Creep Strain (E)

low viscosity in relation the resin composite, *Suprafill* and conventional glass ionomer cement *Vidrion*. Therefore, the absorption by external water of the matrix after the polymerization probably explains a high initial creep of the resin and glass ionomer, and the large deformation in final stress for the *Dyract*. Concerning the static creep behavior a one--factor analysis showed no statistically significant differences between the compomer and glass ionomer. The overall results of the two products tested, the compomer and glass ionomer are considered inferior to the resin composite in restoratives[4, 7].

In many of the materials of interest in classic physics, as well as of practical importance in engineering, viscoelastic anomalies are negligible or of minor significance, however in the resins results had provided valuable. The creep is a property that predicts the future imperfection in the restoration, therefore in polymeric systems, by contrast; mechanical behavior is dominated by viscoelastics phenomena[6].

A prominence of viscoelastics in polymers is not unexpected when one considers the complicated molecular adjustments, which must underlie any macroscopic mechanical deformation. In deformation of the compomer, atoms are displaced from equilibrium positions in fields of force, which are quite local character[3]. These mechanical phenomena reflect a structural imperfection involving distances discontinuously larges than atomic dimensions. In a composite resin, on the other hand, each flexible linear molecule pervades an average volume much greater then atomic dimensions and is continually changing the form, but it may recover part of its contour or deformation when the stress is removed 6. Then, in experiment, a ratio of stress to strain, in resin, is a function of time or frequency alone, and not of stress magnitude.

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